when a first position of the thin film is irradiated with the high energy introduced into the supply chamber, part of the high energy enters the thin film; and

another part of the high energy is reflected by the thin film to form reflected energy [with which] that irradiates a second position of the thin film [is then irradiated] through a course [changed] change of the reflected energy.

Claim 58, line 2, change "substantially" to --approximately--.

Please add new claim 63 as follows:

--63. The method of forming a crystalline film according to Claim 1, wherein the thin film is a metallic thin film.--

REMARKS

Claims 1, 2 and 4-63 are pending. By this Amendment, claim 3 is canceled; claims 1, 12, 20, 25, 30, 35, 40, 46, 56 and 58 are amended; and new claim 63 is added. The specification is amended to address minor informalities. Applicants propose to amend Figs. 3 and 8 to label the specific views in these figures as Figs. 3(A) and 3(B) and 8(A)-8(D), respectively. Reconsideration and allowance are respectfully requested in view of the above amendments and following remarks.

Specification

The Office Action states that the specification does not include a Brief Description of the Several Views of the Drawings. However, the Substitute Specification filed on September 30, 1997 does include a Brief Description of the Drawings at page 15, line 8 to page 16, line 8. Accordingly, Applicants submit that no further amendments are needed in the specification with respect to this rejection.

Objection to Claims

The Office Action objects to claim 3 as reciting line 1 twice. In response, claim 3 is canceled and rewritten as new claim 63 to address this objection.

The Office Action objects to claims 40, 41-43 and 58 for the recitation of the term "substantially." Claims 40 and 58 are amended to change this term to "approximately."

Applicants respectfully submit that the objections are overcome and request they be withdrawn.

Restriction Requirement

Applicants acknowledge that the Restriction Requirement with respect to claims 19, 24, 29, 34, 39, 44, 45 and 50-55 has been made final and that these claims are withdrawn from further consideration. As correctly noted in the Office Action, Applicants intended to cite MPEP § 1800 and not § 800, as the present application is a U.S. National Stage Application.

Rejections Under 35 U.S.C. §102

1. The Office Action rejects claims 1-18 and 62 under 35 U.S.C. §102(b) over Zhang et al. (U.S. Patent No. 5,403,772 to Zhang et al.). Applicants respectfully traverse this rejection with respect to pending claims 1, 2, 4-18 and 62.

Instant claim 1 recites a method of forming a crystalline film, comprising "forming a thin film having a surface on a substrate," and "crystallizing at least a surface layer of the thin film by selectively applying energy to the surface of the thin film, such that at least the surface layer of the thin film is melted and crystallized under a hydrogen-containing atmosphere" (emphasis added). Zhang fails to teach the claimed method.

Zhang discloses a method for manufacturing a semiconductor device. The Zhang method comprises selectively forming films, particles or clusters of metallic materials, as described at col. 6, first paragraph of Zhang, under or on an amorphous silicon film and then annealing the metallic material and amorphous silicon film to crystallize the amorphous silicon. Annealing conditions are described at col. 8, line 11 to col. 9, line 46 of Zhang. Each of the annealing conditions (1)-(12) that are described utilize annealing periods of hours in

each of more than one atmosphere. The annealing (atmosphere) temperature is from 450-1100°C.

Zhang does not teach "crystallizing at least a surface layer of the thin film by selectively applying energy to the surface of the thin film, such that at least the surface layer of the thin film is melted and crystallized under a hydrogen-containing atmosphere," as recited in claim 1. Rather, Zhang applies energy in the same manner to the substrate, metallic material and amorphous silicon during the annealing, and not selectively to a surface of the amorphous silicon. This is readily apparent from the description at col. 9, lines 27-46 of Zhang. Furthermore, Zhang does not teach that at least a surface layer of the amorphous silicon is melted during the annealing. In fact, the upper annealing temperature of 1100°C disclosed in Zhang is well below the melting temperature of silicon and accordingly melting of at least a surface layer of the silicon would not occur during this annealing.

Thus, claim 1 is not anticipated by Zhang. Claims 2 and 5-11 depend from claim 1 and accordingly are also not anticipated by Zhang. For example, the Office Action asserts that the features of claims 9 and 10 are disclosed at col. 19, line 18 of Zhang. However, there is no teaching or suggestion of the features of claims 9 and 10 at this particular location in Zhang. Further, the Office Action asserts that Zhang discloses the features of claim 11 at col. 13, lines 50-52. However, Zhang teaches that optical energy, such as laser annealing or flash lamp annealing, may be used to activate doped impurities. Zhang does not teach that optical energy is used to crystallize at least a surface layer of a thin film as recited in claim 1.

Claim 12 is directed to a method of forming a crystalline film, comprising "forming a semiconductor thin film having a surface on a substrate," and "crystallizing at least the surface layer of the semiconductor thin film by selectively applying energy to the surface of the semiconductor thin film, such that at least the surface layer of the semiconductor thin film

is melted and crystallized under an atmosphere containing a gas containing the component element of the semiconductor thin film" (emphasis added). Claim 12 is also not anticipated by Zhang for the reasons stated above. Claims 13-18 depend from claim 12 and accordingly are also not anticipated by Zhang. For example, Applicants are unable to find any teaching of the features of claims 14 and 15 at the specific locations in Zhang referred to in the Office Action.

Claim 62 is directed to a method of manufacturing a thin film electronic device comprising a crystalline film formed by the method of claim 1. Accordingly, claim 62 is also not anticipated by Zhang for at least the reasons stated above for claim 1.

Therefore, Applicants respectfully request that the rejection be withdrawn.

2. The Office Action rejects claims 20-23, 25-28, 30-33, 35-38 and 46-49 under 35 U.S.C. §102(b) over Nakamura et al. (U.S. Patent No. 5,200,630). Applicants respectfully traverse this rejection.

Instant claim 20 is directed to a method of forming a crystalline film, comprising "crystallizing at least a surface layer of the thin film by selectively supplying high energy to the thin film," wherein "the high energy is supplied to the thin film with the introduction window disposed at a location resistant to adherence of components of the thin film when the high energy is supplied to the thin film" (emphasis added). Nakamura does not teach the recited method.

The Office Action asserts that Nakamura teaches the features of claim 20 in Fig. 6 and at col. 4, line 39 to col. 5, line 11. However, Nakamura is silent regarding the position of the window 52 through which laser light is passed onto amorphous silicon 53. Specifically, Zhang does not teach that the window 52 is "disposed at a location resistant to adherence of components of the thin film when the high energy is supplied to the thin film." As explained at page 17, line 1 to page 18, line 4 of the present specification, the introduction window

needs to be sufficiently separated form the object material to be crystallized, as compared to the scattering range of the object material, so that the components of the object material hardly adhere to the introduction window. Nowhere does Nakamura disclose that the amorphous silicon 53 should be sufficiently separated from the window 52, as compared to the scattering range of components of the amorphous silicon, such that such components hardly adhere to the window. The Office Action provides no basis that this result would inherently occur in Nakamura. Furthermore, it is not proper to assert that the apparatus shown in Fig. 6 includes this feature of claim 20, because nowhere does Nakamura disclose that Fig. 6 is drawn to scale or that the components of the illustrated apparatus are drawn to proportion relative to each other. Thus, Nakamura does not anticipate claim 20. Claims 21-23 depend from claim 20 and accordingly are also not anticipated.

Instant independent claim 25 is directed to a method of forming a crystalline film. The claimed method comprises "crystallizing at least a surface layer of the thin film by supplying high energy to the thin film," wherein "the supply chamber includes a wall and an introduction window provided in a portion of the wall, the introduction window introduces the high energy into the chamber," and "the high energy is supplied to the thin film with a distance between the introduction window and the thin film larger than a shortest distance between the wall and the thin film" (emphasis added). Nakamura fails to teach the method of claim 25.

Nakamura at the least fails to describe or even suggest that "the high energy is supplied to the thin film with a distance between the introduction window and the thin film larger than a shortest distance between the wall and the thin film," as recited in claim 25. To the extent that the Office Action is asserting that Fig. 6 of Nakamura shows this feature of claim 25, Applicants submit that Fig. 6, in fact, shows the opposite. That is, in Fig. 6, the

distance between the window and the silicon 53 appears to be smaller than a shortest distance between the wall and the silicon.

Thus, Nakamura does not anticipate claim 25. Claims 26-28 depend from claim 25 and accordingly are also not anticipated.

Instant independent claim 30 recites a method of forming a crystalline film, comprising "crystallizing at least the surface layer of the thin film by selectively supplying high energy to the thin film," wherein "the high energy is supplied to the thin film under a pressure in a vicinity of the introduction window that is higher than a pressure in the vicinity of the thin film in the supply chamber." Nakamura does not teach the claimed method.

The Office Action asserts that in the Nakamura device, "the pressure in the vicinity of the introduction window is higher (atmospheric) than the pressure (vacuum) in the vicinity of the thin film in the supply chamber." Nakamura teaches at col. 4, last paragraph, that a vacuum is drawn in the chamber 51 in which the amorphous silicon is placed. Hydrogen gas is introduced into the chamber through the inlet 60 and discharged from the chamber through the discharge opening 61. However, Nakamura teaches no specific relationships between the pressures in the vicinity of the window 52 and in the vicinity of the silicon 53. Thus, Nakamura does not specifically teach that the pressure in the vicinity of the window 52 is higher than in the vicinity of the silicon 53.

Therefore, Nakamura does not anticipate claim 30. Claims 31-33 depend from claim 30 and accordingly are also not anticipated by Nakamura.

Instant independent claim 35 is also not anticipated by Nakamura for at least the same reasons as claim 30. Claims 36-38 depend from claim 35 and accordingly are also not anticipated by Nakamura.

Instant claim 46 is directed to a method of forming a crystalline film in which "the thin film is irradiated with the high energy introduced into the supply chamber through the introduction window along a irradiation path assumed in the supply chamber," and "the high energy is supplied to the thin film with the normal direction of the thin film shifted by an angle from the direction of the irradiation path." An embodiment of the claimed invention is shown in Fig. 4, in which the irradiation path is shifted by an angle from the normal line to the thin film. Nakamura fails to teach the method of claim 46.

In Fig. 6 of Nakamura, the irradiation path is parallel to the normal direction of the silicon 53. Further, Nakamura does not teach that the irradiation path could or should be shifted by an angle from the normal direction of the silicon 53.

Thus, Nakamura does not anticipate claim 46. Claims 47-49 depend from claim 46 and accordingly are also not anticipated by Nakamura.

Thus, this rejection is overcome and Applicants respectfully request that the rejection be withdrawn.

Rejection Under 35 U.S.C. §103

The Office Action rejects claims 40-43 and 56-61 under 35 U.S.C. §103(a) over Nakamura in view of JP 62-3809. The Office Action states that JP 62-3809 was submitted by Applicants in an Information Disclosure Statement. However, the Information Disclosure Statement filed on September 30, 1997 cites JP 62-3089. Applicants assume that the Office Action intends to cite JP 62-3089 in this rejection and will respond to this rejection based on this assumption.

Instant independent claim 40 is directed to a method of forming a crystalline film. In the claimed method, "the thin film is irradiated with the high energy introduced into the supply chamber through the introduction window along a irradiation path in the supply chamber," "a part of the high energy enters the thin film, and another part of the high energy

is reflected from the thin film along a reflection path in the supply chamber," "a gas flow is present in the supply chamber," and "the high energy is supplied to the thin film with (i) the gas flow from the introduction window to the thin film in approximately the same direction as the irradiation path, and (ii) the gas flow from the thin film in approximately the same direction as the reflection path" (emphasis added). Nakamura fails to teach the method of claim 40.

As shown in Fig. 3(A), in embodiments of the claimed invention, gas can be introduced into the supply chamber in approximately the same direction as the irradiation path of the high energy. In contrast, in the Nakamura device shown in Fig. 6, the gas is introduced into the chamber 51 through the inlet 60 in a direction that is perpendicular to the path of the laser beam. Nakamura also does not teach a "gas flow from the thin film in approximately the same direction as the reflection path," as claimed.

JP '089 fails to cure the deficiencies of Nakamura with respect to the method of claim 40. The Office Action asserts that JP '089 discloses in Figs. 1 3, 5 and 6 that a part of the high energy is reflected from a thin film. However, JP '089 does not show any such reflection in these figures. Rather, JP '089 shows the object 13 being irradiated by two separate beams that have split from a single beam emitted by the device 1. The two beams are oriented at angles relative to the normal to the object. Further, gas is introduced into the JP '089 chamber through port 211 and exhausted at port 212 and thus does not appear to flow in approximately the same direction as the irradiation path. Thus, JP '089 provides no teaching, suggestion or motivation to modify the Nakamura device such that "(i) the gas flow from the introduction window to the thin film in approximately the same direction as the irradiation path," or "(ii) the gas flow from the thin film in approximately the same direction as the reflection path"

Thus, claim 40 would not have been rendered obvious by Nakamura and JP '089. Claims 41-43 depend from claim 40 and accordingly are also allowable.

Instant claim 56 also would not have been rendered obvious by Nakamura and JP '089 for the reasons stated for claim 40. Claims 57-61 are also allowable for at least the same reasons as claim 56.

Therefore, Applicants respectfully request that this rejection be withdrawn.

For the foregoing reasons, withdrawal of the objections and rejections and allowance of the pending claims are respectfully requested.

Should the Examiner believe anything further is desirable to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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JAO:EAB

Attachment:
Request for Approval of Drawing Corrections

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